

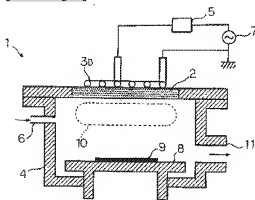
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DRAWINGS

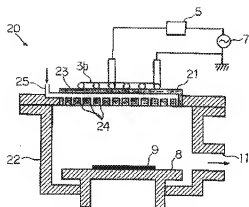
[Drawing 1]



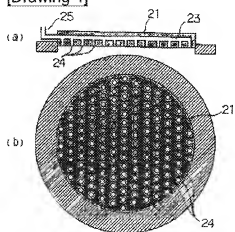
[Drawing 2]



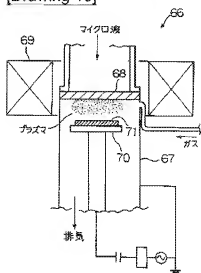
[Drawing 3]



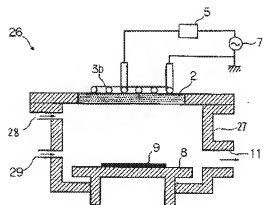
[Drawing 4]



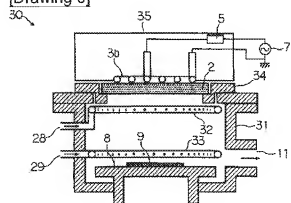
[Drawing 13]



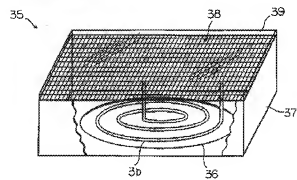
[Drawing 5]



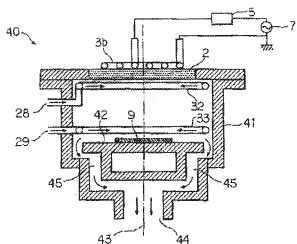
[Drawing 6]



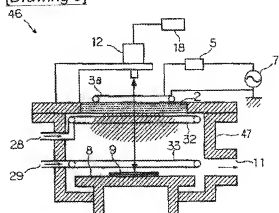
[Drawing 7]



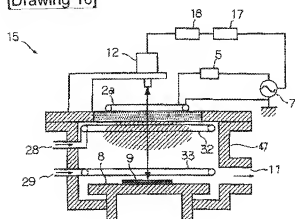
[Drawing 8]



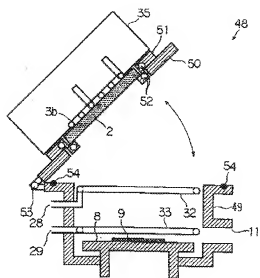
[Drawing 9]



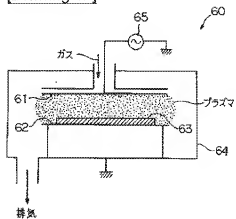
[Drawing 10]



[Drawing 11]



[Drawing 12]



[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the plasma CVD device used for the manufacturing process of an integrated circuit, etc., and in detail, constitute a plasma CVD device using ICP (Inductively Coupled Plasma) which is inductive-coupling type plasma as a plasma generation means, and. Observation of a membrane formation state by CVD is constituted possible, and it is related with the CVD treatment method using the plasma CVD device and this device which could be made to carry out the automatic control of the advance of a membrane formation process, and the cleaning method of this device.

[0002]

[Description of the Prior Art] As conventional technology used for the CVD (Chemical Vapor Deposition-modified chemical vapor deposition) processing in the manufacturing process of an integrated circuit, the parallel-plate-electrodes type plasma CVD device or the ECR (Electron Cyclotron Resonance-electron cyclotron resonance) plasma CVD device is known. The above-mentioned parallel-plate-electrodes type plasma CVD device is constituted as shown in drawing 12 as an outline lineblock diagram. In drawing 12, the upper electrode 61 and the lower electrode 62 which were formed in the vacuum housing 64 plate-like face each other in parallel, the parallel-plate-electrodes type plasma CVD device 60 is arranged, and high-frequency power is impressed to the upper electrode 61 from RF generator 65. The sample 63 which performs CVD treatment is laid on the lower electrode 62, and this lower electrode 62 is connected to earth potentials. If CVD treatment gas is introduced in the vacuum housing 64 from the channel established in the upper electrode 61 so that it may illustrate, plasma will occur between each electrode 61 and 62, the decomposition product of the CVD treatment gas generated by this plasma will accumulate on the sample 63, and membrane formation will be given to the surface of the sample 63. The above-mentioned ECR plasma CVD system is constituted as shown in drawing 13 as an outline lineblock diagram. In drawing 13, a magnetic field is impressed in the vacuum housing 67 from the magnetic field generating coil 69 by which the dielectric window 68 to the microwave provided in the shaft orientations of the vacuum housing 67 in which ECR plasma CVD system 66 was formed cylindrical was introduced in the vacuum housing 67, and it was allocated in the vacuum housing 67 and the same axle. The sample 71 is laid on the sample table 70

allocated in the prescribed position of the shaft orientations of the vacuum housing 67, If CVD treatment gas is introduced in the vacuum housing 67, ECR plasma will occur in the vacuum housing 67, the decomposition product of the CVD treatment gas generated by this plasma will accumulate on the sample 71, and membrane formation will be given to the surface of the sample 71.

[0003]

[Problem(s) to be Solved by the Invention]In the above-mentioned parallel-plate-electrodes type plasma CVD device, Since the decomposition product generated by the problem which the by-product by plasma mixes into a deposited film, and plasma since a sample was put into plasma adheres to an electrode section as particle and is omitted on a sample during membrane formation. The problem that membrane formation quality deteriorates, and since an electrode was further put into plasma, there was a problem of an electrode material having mixed in membrane formation and reducing membrane formation quality. In the above-mentioned ECR plasma CVD system, Since the decomposition product by plasma adheres to the dielectric window which introduces microwave, The homogeneity of plasma density was spoiled, and in order to make the problem and cyclotron resonance which influence as change of the unevenness of thickness, or membrane formation speed, etc. perform, when the problem and sample used as a device that a magnetic field generating coil needs to be installed etc., very large-sized, and expensive large-caliber-ized, there was a problem of also enlarging a device. In the conventional plasma CVD device, since it was impossible to observe the specimen surface under membrane formation, in order to have set up the membrane formation thickness by CVD, the membrane formation speed of the device formed at target thickness was computed, and there was a problem that target membrane formation time had to be set up. This invention is what was made that many problems of the above-mentioned conventional plasma CVD device should be solved, ICP constitutes a plasma CVD device, quality membrane formation which does not have mixing of an impurity into membrane formation is enabled, and observation and thickness measurement of the specimen surface under membrane formation are constituted possible, and it aims at providing the CVD treatment method using the plasma CVD device and this device which enabled membrane formation control.

[0004]

[Means for Solving the Problem]To achieve the above objects, the 1st means that this invention adopts, Introduce, plasma-ize necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, An antenna which is allocated near a dielectric window allocated on an outline of the above-mentioned vacuum housing, and the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, It is constituted as a plasma CVD device having coincided each plane direction and allocating a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing on the same axis of the above-mentioned vacuum housing. In the above-mentioned composition, a dielectric window can be formed with a transparent body and a diameter of a dielectric window and an antenna can be formed more greatly than a diameter of a sample. Introduce, and the 2nd means plasma-izes necessary

CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, It is allocated on an outline of the above-mentioned vacuum housing, and with a dielectric. Size from a diameter of the above-mentioned sample A dielectric window possessing a gas passageway which was formed in a becoming diameter and was connected to an introduction port of the above-mentioned CVD treatment gas, and two or more gas emission openings which emit raw gas of this gas passageway in a vacuum housing, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, It is constituted as a plasma CVD device having coincided each plane direction and allocating a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing on the same axis of the above-mentioned vacuum housing.

[0005]Introduce, and the 3rd means plasma-izes necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, It is allocated on an outline of the above-mentioned vacuum housing, and size from a diameter of the above-mentioned sample with a dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing is allocated, and an outline of a vacuum housing in which the above-mentioned dielectric window was allocated is constituted as a plasma CVD device characterized by coming to be formed so that opening and closing are possible. Introduce, and the 4th means plasma-izes necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, It is allocated on an outline of the above-mentioned vacuum housing, and size from a diameter of the above-mentioned sample with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and. Inspection light is projected on the above-mentioned sample through the above-mentioned dielectric window, and it is allocated by position which can receive catoptric light reflected from a deposited film generated by this specimen surface, and is constituted as a plasma CVD device forming a thickness measurement device which measures thickness of the above-mentioned deposited film by analysis of this catoptric light. A carrier gas introduction means which introduces into an induction field of the above-

mentioned high frequency electric field carrier gas which constitutes the above-mentioned raw gas in the 1st and 2nd, 3rd, and 4th means of the above, A material gas introduction means which introduces CVD material gas which constitutes the above-mentioned raw gas into a headroom of the above-mentioned sample which touches the above-mentioned plasma can be made to provide.

[0006]In the 1st and 2nd, 3rd, and 4th means of the above, it can constitute so that exhaust air in the above-mentioned vacuum housing may be made from two or more exhaust ports established on the circumference centering on the above-mentioned sample position. Size from a diameter of a sample which the 1st method that this invention adopts is allocated on an outline of a vacuum housing, and is arranged in the above-mentioned vacuum housing with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and, Project inspection light on the above-mentioned sample through the above-mentioned dielectric window, and catoptric light reflected from a deposited film generated by this specimen surface is allocated by position which can receive light, and by analysis of this catoptric light. The above-mentioned CVD treatment gas which possessed a thickness measurement device which measures thickness of the above-mentioned deposited film, was constituted, and was introduced in the above-mentioned vacuum housing with the above-mentioned antenna. In a plasma-CVD disposal method using a plasma CVD device which makes a decomposition product which plasma-ized by a high frequency electric field induced in a vacuum housing, and was disassembled by this plasma deposit on the above-mentioned sample, A plasma-CVD disposal method stopping supply of high-frequency power to the above-mentioned antenna when deposited film thickness of a specimen surface in the above-mentioned deposition process is measured with the above-mentioned thickness measurement device and this measured value becomes desired thickness. It comes out.

[0007]Size from a diameter of a sample which the 2nd method is allocated on an outline of a vacuum housing, and is arranged in the above-mentioned vacuum housing with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and, Project inspection light on the above-mentioned sample through the above-mentioned dielectric window, and catoptric light reflected from a deposited film generated by this specimen surface is allocated by position which can receive light, and by analysis of this catoptric light. The above-mentioned CVD treatment gas which possessed a thickness measurement device which measures thickness of the above-mentioned deposited film, was constituted, and was introduced in the above-mentioned vacuum housing with the above-mentioned antenna. In a plasma-CVD disposal method using a plasma CVD device which makes a decomposition product which plasma-ized by a high

frequency electric field induced in a vacuum housing, and was disassembled by this plasma deposit on the above-mentioned sample. Measure deposited film thickness of a specimen surface with the above-mentioned thickness measurement device, when this measured value becomes desired thickness, change both an ingredient of CVD material gas, reactant gas, and dilution gas, and both [one side or] which constitute the above-mentioned CVD treatment gas, and CVD of different species. It is a plasma-CVD disposal method performing film deposition continuously. With an antenna by which the 3rd method was allocated near [which was established in a vacuum housing] the dielectric window. Induce a high frequency electric field in this vacuum housing, plasma-ize CVD treatment gas introduced in a vacuum housing, and by this plasma. In a cleaning method of a plasma CVD device which makes a disassembled decomposition product deposit on a sample arranged in the above-mentioned vacuum housing, After introducing necessary CVD treatment gas in the above-mentioned vacuum housing and performing plasma-CVD processing, it is a cleaning method of a plasma CVD device replacing with CVD treatment gas, introducing fluoridation gas in the above-mentioned vacuum housing, and performing washing in the above-mentioned CVD system by plasma by this fluoridation gas.

[0008]

[Function]According to the invention of the 1st of this application, if high-frequency power is supplied to the antenna allocated near [which was established in the outline of the vacuum housing] the dielectric window, a high frequency electric field will be induced in a vacuum housing by the electromagnetic waves from an antenna. The CVD treatment gas introduced by this high frequency electric field in the vacuum housing is plasma-ized, and membrane formation is made in a specimen surface by making the decomposition product generated by this plasma deposit on the sample arranged in a vacuum housing. Since the above-mentioned dielectric window, an antenna, and a sample table coincide a plane direction and are allocated on the same axis of a vacuum housing, the plasma generated in a vacuum housing is spread and the CVD operation which makes the decomposition product by plasma deposit to a sample is made uniformly. A CVD operation on a sample is made still more uniformly by forming the diameter of the above-mentioned dielectric window and an antenna in size from the diameter of a sample. Since a transparent dielectric window and sample table are allocated in the same flat surface, the stages of progress of membrane formation by deposition of this decomposition product become possible [observing through a dielectric window]. Claim 1 and claims 2 and 3 correspond to this. Since according to the invention of the 2nd of this application it combines with the composition by the 1st above-mentioned invention, the gas passageway of CVD treatment gas and the gas emission opening into a vacuum housing are provided in a dielectric window and CVD treatment gas is introduced in a vacuum housing through the above-mentioned gas passageway and a gas emission opening. Supply of raw gas is uniformly made to a plasma generating region. Claim 4 corresponds to this. According to the invention of the 3rd of this application, cleaning of receipts and payments of the sample into a vacuum housing, the internal surface of a vacuum housing, and a dielectric window inner surface, etc. can carry out easily by combining with the composition by the 1st above-mentioned invention, and constituting the outline of the vacuum housing in which the above-mentioned dielectric window was allocated so that opening and closing are possible. Claim 5 corresponds to this. According to the invention of the 4th of this

application, it combines with the composition of an invention of the above 1st, a thickness measurement device is allocated, and the thickness of the membrane formation process of the specimen surface which advances within a vacuum housing can be measured at any time. Therefore, when it becomes measurement of the distribution state of the membrane formation thickness on a sample, or predetermined thickness, control etc. which stop operation of a device can be carried out. Claim 6 corresponds to this. [0009]By establishing the carrier gas introduction means and material gas introduction means which separate into carrier gas and CVD material gas, and supply CVD treatment gas in the 1st and 3rd, and 4th above-mentioned invention, Since carrier gas can be plasma-ized by the electromagnetic waves from an antenna and the plasma can be made to decompose CVD material gas, with the decomposition product of CVD material gas, the membrane formation to a sample is made preponderantly and can raise membrane formation quality. Claim 7 corresponds to this. By performing the exhaust air out of a vacuum housing uniformly from the circumference centering on a sample position, the flow of the gas in a vacuum housing becomes uniform to a sample, and uniform membrane formation is made, and adhesion of the decomposition product into a dielectric window or a vacuum housing is controlled. Claim 8 corresponds to this. The invention of the 5th of this application is what shows the CVD treatment method using the composition by the 4th above-mentioned invention, When the membrane formation thickness on a sample is measured with a thickness measurement device, the measured value becomes predetermined thickness and it controls to stop impression of the high-frequency power from an antenna, the CVD treatment method that membrane formation by fixed thickness can always be carried out is provided. Claim 9 corresponds to this. The invention of the 6th of this application is what shows the CVD treatment method of carrying out two or more sorts of membrane formation continuously using the composition by the 4th above-mentioned invention, When the membrane formation thickness on a sample is measured with a thickness measurement device and the measured value becomes predetermined thickness, the CVD treatment method which membrane formation of a different kind can enforce succeedingly is provided by changing both the ingredient of CVD treatment gas, and both [one side or]. Claim 10 corresponds to this. The invention of the 7th of this application is what shows the cleaning method in the plasma CVD device which becomes the above-mentioned composition, After performing CVD treatment which introduced CVD treatment gas in the vacuum housing, replace with CVD treatment gas, and introduce fluorine gas in a vacuum housing, it is made to plasma-ize, and an etching process removes the CVD film which adhered to the wall and dielectric window of the vacuum housing by this plasma. The transparent state of a dielectric window and the introductory state of high-frequency power are reformed completely by this washing. The stable CVD film formation is maintained by performing this washing at any time. Claim 11 corresponds to this.

[0010]

[Example]It explains hereafter per [which materialized this invention with reference to the accompanying drawing] example, and an understanding of this invention is presented. The following examples are examples which materialized this invention, and do not limit the technical scope of this invention. The mimetic diagram showing the composition of the plasma CVD device which requires drawing 1 for the 1st example of this invention here, and drawing 2 are the top views showing the composition of the antenna

concerning an example. In drawing 1, the plasma CVD device 1 concerning the 1st example, The vacuum housing 4 which was formed cylindrical and provided with the gas introducing port 6 and the exhaust port 11 for evacuation, The dielectric window 2 which was provided on the axis line of this vacuum housing 4, and was formed with transparent silica glass. The antenna 3 arranged near this dielectric window 2, RF generator 7 which supplies high-frequency power to this antenna 3 via the matching network 5, and the sample table 8 which is allocated in the optional position on the axis line of the above-mentioned vacuum housing 4 movable, and lays the sample 9 are provided, and it is constituted. In the above-mentioned composition, on the medial axis of the vacuum housing 4, the above-mentioned antenna 3, the dielectric window 2, the sample table 8, and the sample 9 coincide each plane direction, and are allocated. The dielectric window 2 is formed in a diameter bigger enough than the diameter of the sample 9 by which CVD treatment is carried out, and is allocated on the top outline of the vacuum housing 4. The antenna 3 can be formed as a spiral loop antenna shown in one loop or drawing 2 (b) shown in drawing 2 (a). In the plasma CVD device 1 shown in drawing 1, the diameter of the spiral loop shown in drawing 2 (b) adopts the antenna 3b formed more greatly than the diameter of the sample 9, and lets the dielectric window 2 pass. It is constituted so that high-frequency power uniform to concentric circle shape can be introduced in the direction of a wall from the axis line of this vacuum housing 4 in the vacuum housing 4.

[0011]By the above-mentioned composition, exhaust the inside of the vacuum housing 4 from the exhaust port 11, and. If CVD treatment gas is introduced from the gas introducing port 6 and high-frequency power is impressed to the antenna 3b from RF generator 7, A high frequency electric field is induced in the vacuum housing 4 by the electromagnetic waves from the antenna 3b, and this high frequency electric field accelerates the electron by which it was generated in the vacuum housing 4 by natural radiation etc., collides with the neutral atom in CVD treatment gas, ionizes this neutral atom, and generates ion and an electron. A high frequency electric field accelerates and the electron by which it was newly generated repeats the process in which ion and an electron are generated. If it does in this way and plasma density rises above to some extent, the electron density in plasma rises, the response frequency of the electron in plasma is raised, current will flow as if it acts just like a conductor and intercepted the high frequency electric field, and plasma will begin to intercept electromagnetic waves. In order that electromagnetic waves may not go into the inside of plasma other than the special mode peculiar to plasma at this time, the energy of the electromagnetic waves from the antenna 3b is acquired, and only surface plasma raises plasma density further and diffuses it inside plasma. The decomposition product of the raw gas generated by the plasma 10 generated as mentioned above is deposited on the sample 9. If the sample 9 arranges a specimen surface (portion to make it form a deposited film in) in the position which makes move the sample table 8 and is not directly put to the plasma 10, a precise CVD film without mixing of an impurity will be formed during membrane formation. Since the diameter of the dielectric window 2 and the antenna 3b is formed more greatly than the diameter of the sample 9, and the dielectric window 2, the antenna 3b, and the sample 9 coincide a plane direction and are allocated on the same axis, respectively as the above-mentioned composition is shown in drawing 1, If the sample 9 is seen through from the transparent dielectric window 2, the whole specimen surface can be observed. It becomes possible to observe the state where membrane

formation is made on the sample 9 surface, at any time by this composition. Although introduction of raw gas was made from the side of the vacuum housing 4, membrane formation by CVD can be made to equalize more in the above-mentioned 1st example composition by equalizing the density distribution of the raw gas in the required position in the vacuum housing 4. It explains below by making composition aiming at equalization of the density distribution of this raw gas into the 2nd example. The same numerals are given to the same element as the composition of the 1st example of the above, and the explanation is omitted.

[0012]Drawing 3 is a mimetic diagram showing the composition of the plasma CVD device 20 concerning the 2nd example in a section. In this composition, introduction of the raw gas into the vacuum housing 22 is made from the gas passageway 23 provided in the dielectric window 21, and the gas emission opening 24 of a large number which carry out an opening into the vacuum housing 22 from this gas passageway 23.

Drawing 4 (b) is the top view which looked at the dielectric window 21 out of the vacuum housing 22, and the gas emission opening 24 and 24 -- are arranged almost uniformly all over the dielectric window 21, and as shown in drawing 4 (a), it is opening each gas emission opening 24 for free passage to the gas passageway 23 formed in the dielectric window 21. The gas passageway 23 is connected to the gas introducing port 25, and the raw gas supplied is introduced in the vacuum housing 22 from each gas emission opening 24 through the gas passageway 23 from the gas introducing port 25. In this composition, since raw gas is introduced in the vacuum housing 22 from many gas emission openings 24, as a result of making uniformly the density distribution in the plasma production field of raw gas, the density distribution of plasma is also equalized and membrane formation by CVD is also equalized. Especially, in about [-10Torr] medium-voltage power, since the uniform flow of the raw gas to the sample 9 can be made, uniform membrane formation can carry out also to the sample of a large area. Although the above-mentioned raw gas is constituted including the carrier gas for generating plasma, and the CVD material gas used as the material of membrane formation, it can aim at improvement in membrane formation quality by introducing this carrier gas and CVD material gas into the necessary field in a vacuum housing independently. This composition is explained below as the 3rd example and the 4th and 5th example. The same numerals are given to the element which is common in the 1st and 2nd examples of the above, and the explanation is omitted. The mimetic diagram showing here the composition of the plasma CVD device which drawing 5 requires for the 3rd example, the mimetic diagram showing the composition of the plasma CVD device which drawing 6 requires for the 4th example, the perspective view showing the composition of the shield box which drawing 7 requires for an example, and drawing 8 are the mimetic diagrams showing the composition of the plasma CVD device concerning the 5th example.

[0013]In drawing 5, the plasma CVD device 26 concerning the 3rd example is constituted so that it may separate into carrier gas and CVD material gas and introduction of the raw gas into the vacuum housing 27 may be performed. The above-mentioned carrier gas is supplied in the vacuum housing 27 from the carrier gas introduction port 28, and is introduced into the lower space of the dielectric window 2. The above-mentioned CVD material gas is supplied in the vacuum housing 27 from the material gas introduction port 29, and is introduced into the upper space of the sample 9. Carrier gas is plasma-ized by the above-mentioned composition by the electromagnetic waves impressed in the vacuum housing 27 through the

dielectric window 2 from the antenna 3b, and CVD material gas is plasma-ized by this plasma. Unlike a previous example, with this composition, the raw gas with which carrier gas and CVD material gas were mixed is not plasma-ized, Since the CVD material gas used as membrane formation material is decomposed by the plasma of carrier gas, as a result of making membrane formation preponderantly with the decomposition product of CVD material gas, the quality membrane formation with little mixing of an impurity is made. In order to equalize the density distribution in the vacuum housing 27 of the carrier gas and CVD material gas in the above-mentioned 3rd example composition and to raise equalization of membrane formation, composition as shown in drawing 6 is employable. In drawing 6, the plasma CVD device 30 concerning the 4th example, The material gas introduction ring 33 is allocated in the lower space of the dielectric window 2 in the vacuum housing 31 in the upper space of the carrier gas introduction ring 32 and the sample table 8, and it is connected and constituted by the carrier gas introduction port 28 and the material gas introduction port 29, respectively. The above-mentioned carrier gas introduction ring 32 and the material gas introduction ring 33 make the inner skin of the pipe formed in a circle carry out the opening of many gas emission openings uniformly, and are formed in it, and each gas is emitted to the central direction of an annular ring from a gas emission opening. Therefore, each gas is introduced by uniform density distribution in each annular ring.

[0014]In this composition, the circular support member 34 allocated in the top outline of the vacuum housing 31 is equipped with the dielectric window 2, and it can change the distance of the sample table 8 and the dielectric window 2 by changing the thickness of the dielectric window supporting position of this support member 34. The upper part of the dielectric window 2 is covered in the shield box 35 which includes the antenna 3b. This shield box 35 covers the electromagnetic waves emitted to the outside direction of the vacuum housing 31 from the antenna 3b, and as shown in drawing 7, it is constituted. In drawing 7, the shield box 35 closes the upper part of the aluminium container 37 which formed the opening 36 which accommodates the antenna 3b in the lower part by the side of the dielectric window 2, and was formed in case shape with the aluminum network 38 and the acrylic board 39, and is formed in electromagnetic shielding structure. By forming this shield box 35, the influence of the electromagnetic waves to the human body which approaches the nearby position of the dielectric window 2 in the case of observation of the membrane formation which advances within the vacuum housing 31 can be eliminated. Observation of membrane formation is made by seeing the sample 9 on the sample table 8 through the transparent acrylic board 39, the aluminum network 38, and the dielectric window 2, without receiving radiation of the electromagnetic waves from the antenna 3b. In the composition of the 4th example of the above, although equalization of the density distribution of introductory gas is attained, improvement in the further equalization can be realized by improving the exhaust structure out of a vacuum housing. As for the 5th example composition shown in drawing 8, improvement of this exhaust structure is made. In the plasma CVD device 40 concerning the 5th example shown in drawing 8, equalizing the flow of exhaust air is made by forming exhaust structure with exhaust air conductance equal to the vacuum housing 41 to the medial axis of this vacuum housing 41. Since other composition is equivalent to the above-mentioned 4th example composition, the explanation is omitted.

[0015]In drawing 8, on the medial axis 43 of the vacuum housing 41, the antenna 3b, the dielectric window 2, the carrier gas introduction ring 32, the material gas introduction ring 33, the sample 9, and the sample table 42 coincide each medial axis, and each plane direction is coincided and it is allocated. The exhaust port 45 in the vacuum housing 41 connected with the exhaust port 44 is formed in the circumference of the sample table 42 as two or more exhaust ports 45 by which equivalent arrangement was carried out considering the medial axis 43 of the vacuum housing 41 as a center, and 45 --. In the above-mentioned example, although the exhaust port 45 is arranged symmetrically with four places to the medial axis 43, the diameter of an exhaust port, shape, a total, and an interval can be changed according to the state of a device. The exhaust port 45 may be formed in the circumference of the sample table 42 in a circle, and may perform support of the sample table 45 by an appropriate means separately. The flow of the CVD treatment gas to the sample 9 is equalized by this composition, and uniform membrane formation to the sample 9 is carried out by the uniform flow of the decomposition product by plasma. The effect that adhesion of a decomposition product in the dielectric window 2 or the vacuum housing 41 is controlled is also realized simultaneously. Since the flow of gas becomes equivalent considering the sample table 42 as a center even if it applies not only to application in the 4th example shown in drawing 8 but to other composition, equalization of membrane formation of this exhaust structure improves. Next, the above-mentioned plasma CVD device 30 explains below the result of having carried out operation which makes the surface forming silicon oxide, by making an 8-inch silicon wafer into the sample 9. The antenna 3b which formed silica glass in discoid (29 cm in diameter and 2 cm in thickness), and formed a 1/4-inch copper pipe in the whorl loop of 3 turns with the overall diameter of 20 cm at the upper surface as the dielectric window 2 shown in drawing 6 is arranged, and the high-frequency power of necessary frequency is impressed. Gas introduction into the vacuum housing 31 allocates each in a position (13 cm and 1.5 cm) from the sample table 8 using the carrier gas introduction ring 32 and the material gas introduction ring 33 which were formed in 35 cm in diameter.

[0016]On the basis of the above-mentioned composition, by Ar (argon) bubbling from the material gas introduction port 29. Maintain a TEOS (ethyl silicate) steam at prescribed temperature, carry out control of flow of the O_2 (oxygen) by the gas mass flow of 0 - 200sccm, respectively from the gas mass flow of 5 - 60sccm, and the carrier gas introduction port 28, carry out gas introduction and. Exhaust air is performed from the exhaust port 11, and the growth pressure in the vacuum housing 31 is controlled to 0.1 - 1.0Torr. The high-frequency power to the antenna 3 controls the temperature of 200W-2kW and the sample table 8 at room temperature -400 **. The refractive index of the silicon oxide formed by the above-mentioned film formation condition was set to 1.455, and the value comparable as an oxidizing film was shown. As for membrane formation speed, high speed film formation of 5000Å / min was realized, and the membrane formation distribution within a field was 5%. The HF-proof nature (dirty rate to an HF aqueous solution) of silicon oxide was able to raise membrane quality by leaps and bounds compared with the TEOS-silicon oxide at the time of using the parallel plate type plasma CVD device reported conventionally or an ECR plasma CVD system. The result almost equal to the case where the step coverage nature (step coverage) of silicon oxide is based on the parallel plate type plasma CVD device reported conventionally was obtained.

On the above-mentioned film formation condition, also when only the mixed gas of O_2 and Ar or Ar was used for carrier gas, the equivalent result was obtained. The above result is made only by the equipment configuration and plasma generation means which become this invention, when TEOS which is a macromolecular organic material is made the plasma CVD device which has a high-density plasma generation means conventionally with material gas, it has been supposed that the outstanding step coverage nature is not obtained, but. It was proved by the plasma CVD device which becomes this composition that the result of having excelled is obtained. In the plasma CVD device which becomes this example as explained above, there is the feature which can observe the state of the CVD film formation performed to a sample through a transparent dielectric window. With a thickness measurement device, measurement of the thickness of a membrane formation process is attained using the composition which can observe the surface of this sample 9. It explains below by making this composition into the 6th and 7th examples.

[0017]The mimetic diagram showing the composition of the plasma CVD device which requires drawing 9 for the 6th example here, and drawing 10 are the mimetic diagrams showing the composition of the plasma CVD device concerning the 7th example. In drawing 9, the plasma CVD device 46 concerning the 6th example allocates the thickness measurement device 12 in the shaft orientations of the vacuum housing 47, and is constituted. This thickness measurement device 12 measures thickness by the light reflex spectrum from the membrane formation surface, projects a measuring beam on the sample 9 through the transparent dielectric window 2, catches that catoptric light, carries out the spectrum of the catoptric light, and calculates thickness by the computer 18 from the cycle of a spectrum spectrum. Since the time which calculation of one measurement and thickness takes the thickness measurement device 12 used by this example is about 2 seconds, the thickness in every 2 seconds and the membrane formation speed in every 2 seconds are measured. A membrane formation process is controllable by the measured value output of the above-mentioned thickness measurement device 12. It explains below by making this composition into the 7th example. In drawing 10, the plasma CVD device 15 concerning the 7th example is combined with the composition by the 6th example of the above, forms the control device 17 and is constituted. This control device 17 operates with the output value of the computer 18 which calculates thickness from the measurement data of the thickness measurement device 12, and controls RF generator 7. Since the control device 17 operates with the output signal from the computer 18 and the output of RF generator 7 is stopped when the thickness of a membrane formation process is measured by the thickness measurement device 12 and the computer 18 and membrane formation thickness turns into predetermined thickness, The high-frequency power impressed in the vacuum housing 4 from the antenna 3 stops, and membrane formation is completed. Although the above-mentioned composition is control of one kind of membrane formation, the CVD treatment method which controls two or more kinds of membrane formation continuously can be enforced using membrane formation thickness being detectable with the thickness measurement device 12. This method is made into the 8th example and explained below. As a continuation method for film deposition by this example, after forming NSG (silicon oxide) on a silicon wafer, the case where a PSG film (silicon oxide by which Lynn was added) is formed is shown as an example.

[0018] Arrange in the vacuum housing 47 by making a silicon wafer into the sample 9, and in the vacuum housing 47 as CVD treatment gas, The carrier gas introduction port 28 to TEOS (ethyl silicate) by argon bubbling and O₂ (oxygen) are introduced from the material gas introduction port 29, and silicon oxide is made to form in the surface of the sample 9. Membrane formation is continued until the thickness of this membrane formation grows up into 500 Å, addition introduction of the PH₃ (phosphine) is newly carried out into the vacuum housing 47, without next stopping plasma, and 8000Å of PSG films are formed. Then, a reflow (known art which a deposited film is made to flow and is smoothed by performing heat treatment of not less than 900 °C) is given to a PSG film, and a flat film is formed. In order to form the continuous bipolar membrane with the raw gas with which the ingredient differed from the mixture ratio without suspending generating of plasma according to the described method, When forming two kinds of films of NSG-PSG as mentioned above, in order that membrane formation distance can be simplified and a repetition of turning on and off of plasma may decrease, raw gas is not put to the unstable plasma especially immediately after generating of plasma, and the CVD film where quality was stabilized is obtained. In the plasma CVD device explained above, the sediment for membrane formation adheres to the dielectric window 2 put to plasma, and fluoroscopy of the sample 9 or measurement of the thickness measurement device 12, and also impression of the high-frequency power from the antenna 3 become uneven. Then, the dielectric window 2 is cleaned by performing cleaning or washing in the vacuum housing 4 at any time. The cleaning method in the composition which can perform cleaning in this device easily, and a device is made into the 9th example and the 10th example, and is explained below. Drawing 11 shows the composition of the plasma CVD device 48 concerning the 9th example, and it is constituted so that the top outline 50 of the vacuum housing 49 can open and close with the dielectric window 2 and the antenna 3.

[0019] In drawing 11, the support member 51 is attached to the top outline 50 of the vacuum housing 49, and the top outline 50 is equipped with the dielectric window 2 by this support member 51. It is surrounded by the shield box 35 previously explained to the dielectric window 2, and the antenna 3 is arranged. In this composition, the cooling water circuit 52 is formed so that it may illustrate to the above-mentioned support member 51, and control of the rise in heat of the dielectric window 2 accompanying the high-frequency power injection to the antenna 3 is achieved. On the hinge 53 which makes the end of the vacuum housing 49 a fulcrum, the top outline 50 in which the dielectric window 2 and the antenna 3 were carried as mentioned above is attached to the main part of the vacuum housing 49 so that opening and closing are possible. In order to maintain the airtight structure of the vacuum housing 49 which made the top outline 50 opening and closing structure, the airtight ring 54 is formed in the vacuum housing 49. Since the upper part of the vacuum housing 49 will be wide opened if the top outline 50 is opened as shown in drawing 11, receipts and payments of the sample 9 not only become easy, but cleaning by the side of the wall of the vacuum housing 49 and the inner surface of the dielectric window 2 can carry out easily. Subsequently, how the plasma generated in a vacuum housing performs washing in a vacuum housing is explained as the 10th example. It is an example in the case of carrying out with the plasma CVD device 30 concerning the 4th example shown in drawing 6. In other composition, it can carry out similarly. When membrane formation of a

CVD film is completed, SF_6 and O_2 which are fluoridation gas are introduced from the carrier gas introduction port 28 into the vacuum housing 31, Plasma is generated like the time of membrane formation, and the sediment which adhered in the dielectric window 2 and the vacuum housing 31 by etching by this plasma is removed. SF_6 is set to 30sccm, it sets O_2 to 30sccm, and a gas mass flow sets supplied power to 0.1Torr and the antenna 3 to 2 kW for the pressure in the vacuum housing 31, and performs washing motion over 30 minutes. The silicon oxide which adhered to the wall of the vacuum housing 31 and the inner surface of the dielectric window 2 by the plasma generation for this washing is removed by the etching operation of plasma.

[0020]

[Effect of the Invention]According to the 1st invention, make it possible to use inductive-coupling type plasma (ICP) as a plasma CVD device, and. By coinciding a plane direction and allocating an antenna, a dielectric window, and a sample table on the same axis of a vacuum housing, the effect that the uniform membrane formation by the plasma of uniform density distribution is made is done so. (Claim 1)
When a dielectric window is formed with a transparent body and the plane direction of a dielectric window and a sample table is in agreement, the stages of progress of membrane formation can observe through a dielectric window. (Claim 2)

Since the diameter of an antenna and a dielectric window is formed more greatly than the diameter of a sample, equalization of membrane formation is made also to the sample of a large area. (Claim 3)

According to the 2nd invention, since the gas passageway of CVD treatment gas and the gas emission opening into a vacuum housing are provided in a dielectric window and CVD treatment gas is introduced in a vacuum housing through the above-mentioned gas passageway and a gas emission opening, supply of raw gas is uniformly made to a plasma generating region. (Claim 4)

According to the invention of the 3rd of this application, cleaning of receipts and payments of the sample into a vacuum housing, the wall of a vacuum housing, and a dielectric window inner surface, etc. can carry out easily by combining with the composition by the 1st above-mentioned invention, and constituting the outline of the vacuum housing in which the above-mentioned dielectric window was allocated so that opening and closing are possible. (Claim 5)

According to the invention of the 4th of this application, it combines with the composition of an invention of the above 1st, a thickness measurement device is allocated, and the thickness of the membrane formation process of the specimen surface which advances within a vacuum housing can be measured at any time. Therefore, when it becomes measurement of the distribution state of the membrane formation thickness on a sample, or predetermined thickness, control etc. which stop operation of a device can be carried out. (Claim 6)

[0021]By establishing the carrier gas introduction means and material gas introduction means which separate into carrier gas and CVD material gas, and supply CVD treatment gas in the 1st and 3rd, and 4th above-mentioned invention, Since carrier gas can be plasma-ized by the electromagnetic waves from an antenna and the plasma can be made to decompose CVD material gas, with the decomposition product of CVD material gas, the membrane formation to a sample is made preponderantly and can raise membrane

formation quality. (Claim 7)

By performing the exhaust air out of a vacuum housing uniformly from the circumference centering on a sample position, the flow of the gas in a vacuum housing becomes uniform to a sample, and uniform membrane formation is made, and adhesion of the decomposition product into a dielectric window or a vacuum housing is controlled. (Claim 8)

According to the invention of the 5th of this application, when the membrane formation thickness on a sample is measured with a thickness measurement device, the measured value becomes predetermined thickness and it controls to stop impression of the high-frequency power from an antenna, the CVD treatment method that membrane formation by fixed thickness can always be carried out is provided. (Claim 9)

According to the invention of the 6th of this application, when the membrane formation thickness on a sample is measured with a thickness measurement device and the measured value becomes predetermined thickness, the CVD treatment method which membrane formation of a different kind can enforce succeedingly is provided by changing both the ingredient of CVD treatment gas, and both [one side or]. (Claim 10)

According to the invention of the 7th of this application, after performing CVD treatment which introduced CVD treatment gas in the vacuum housing, replace with CVD treatment gas, and introduce fluorine gas in a vacuum housing, it is made to plasma-ize, and an etching process removes the CVD film which adhered to the dielectric window by this plasma. The transparent state of a dielectric window and the introductory state of high-frequency power are reformed completely by this washing. The stable CVD film formation is maintained by performing this washing at any time. (Claim 11)

[Translation done.]

* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] Introduce, plasma-size necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, An antenna which is allocated near a dielectric window allocated on an outline of the above-mentioned vacuum housing, and the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, A plasma CVD device having coincided each plane direction and allocating a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing on the same axis of the above-mentioned vacuum housing.

[Claim 2] Introduce, plasma-size necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, It is allocated on an outline of the above-mentioned vacuum housing, and with a dielectric. Size from a diameter of the above-mentioned sample A dielectric window possessing a gas passageway which was formed in a becoming diameter and was connected to an introduction port of the above-mentioned CVD treatment gas, and two or more gas emission openings which emit raw gas of this gas passageway in a vacuum housing, A plasma CVD device having been allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, having coincided each plane direction and allocating an antenna which induces a high frequency electric field in a vacuum housing, and a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing on the same axis of the above-mentioned vacuum housing.

[Claim 3] The plasma CVD device according to claim 1 or 2 which it comes to form so that opening and closing of an outline of a vacuum housing in which the above-mentioned dielectric window was allocated are possible.

[Claim 4] Introduce, plasma-size necessary CVD treatment gas in a vacuum housing in which high-frequency power was impressed, and by this plasma. In a plasma CVD device which makes a decomposition product

of the decomposed above-mentioned CVD treatment gas deposit on a sample arranged in the above-mentioned vacuum housing, It is allocated on an outline of the above-mentioned vacuum housing, and size from a diameter of the above-mentioned sample with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and. A plasma CVD device forming a thickness measurement device which projects inspection light on the above-mentioned sample through the above-mentioned dielectric window, is allocated by position which can receive catoptric light reflected from a deposited film generated by this specimen surface, and measures thickness of the above-mentioned deposited film by analysis of this catoptric light.

[Claim 5]A carrier gas introduction means which introduces into an induction field of the above-mentioned high frequency electric field carrier gas which constitutes the above-mentioned raw gas, The plasma CVD device possessing a material gas introduction means which introduces CVD material gas which constitutes the above-mentioned raw gas into a headroom of the above-mentioned sample which touches the above-mentioned plasma according to any one of claims 1 to 4.

[Claim 6]The plasma CVD device according to any one of claims 1 to 5 constituted so that exhaust air in the above-mentioned vacuum housing might be made from two or more exhaust ports established on the circumference centering on the above-mentioned sample position.

[Claim 7]The plasma CVD device according to any one of claims 1 to 6 from which it comes to constitute the above-mentioned dielectric window with a transparent body.

[Claim 8]The plasma CVD device according to any one of claims 1 to 7 with which it comes to form a diameter of the above-mentioned dielectric window, and a diameter of the above-mentioned antenna more greatly than a diameter of the above-mentioned sample.

[Claim 9]Size from a diameter of a sample which is allocated on an outline of a vacuum housing and arranged in the above-mentioned vacuum housing with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and. Project inspection light on the above-mentioned sample through the above-mentioned dielectric window, and catoptric light reflected from a deposited film generated by this specimen surface is allocated by position which can receive light, and by analysis of this catoptric light. The above-mentioned CVD treatment gas which possessed a thickness measurement device which measures thickness of the above-mentioned deposited film, was constituted, and was introduced in the above-mentioned vacuum housing with the above-mentioned antenna. In a plasma-CVD disposal method using a plasma CVD device which makes a decomposition product which plasma-ized by a high frequency electric

field induced in a vacuum housing, and was disassembled by this plasma deposit on the above-mentioned sample, A plasma-CVD disposal method stopping supply of high-frequency power to the above-mentioned antenna when deposited film thickness of a specimen surface in the above-mentioned deposition process is measured with the above-mentioned thickness measurement device and this measured value becomes desired thickness.

[Claim 10]Size from a diameter of a sample which is allocated on an outline of a vacuum housing and arranged in the above-mentioned vacuum housing with a transparent dielectric A dielectric window which it comes to form in a becoming diameter, An antenna which is allocated near the above-mentioned dielectric window besides the above-mentioned vacuum housing, and induces a high frequency electric field in a vacuum housing, On the same axis of the above-mentioned vacuum housing, coincide each plane direction, and allocate a sample table which holds the above-mentioned sample to a prescribed position in the above-mentioned vacuum housing, and. Project inspection light on the above-mentioned sample through the above-mentioned dielectric window, and catoptric light reflected from a deposited film generated by this specimen surface is allocated by position which can receive light, and by analysis of this catoptric light. The above-mentioned CVD treatment gas which possessed a thickness measurement device which measures thickness of the above-mentioned deposited film, was constituted, and was introduced in the above-mentioned vacuum housing with the above-mentioned antenna. In a plasma-CVD disposal method using a plasma CVD device which makes a decomposition product which plasma-ized by a high frequency electric field induced in a vacuum housing, and was disassembled by this plasma deposit on the above-mentioned sample, . Measure deposited film thickness of a specimen surface with the above-mentioned thickness measurement device, when this measured value becomes desired thickness, change both an ingredient of CVD material gas, reactant gas, and dilution gas, and both [one side or] which constitute the above-mentioned CVD treatment gas, and perform CVD film deposition of different species continuously. A plasma-CVD disposal method characterized by things.

[Claim 11]With an antenna allocated near [which was established in a vacuum housing] the dielectric window. Induce a high frequency electric field in this vacuum housing, plasma-ize CVD treatment gas introduced in a vacuum housing, and by this plasma. In a cleaning method of a plasma CVD device which makes a disassembled decomposition product deposit on a sample arranged in the above-mentioned vacuum housing, A cleaning method of a plasma CVD device replacing with CVD treatment gas, introducing fluoridation gas in the above-mentioned vacuum housing, and performing washing in the above-mentioned CVD system by plasma by this fluoridation gas after introducing necessary CVD treatment gas in the above-mentioned vacuum housing and performing plasma-CVD processing.

[Translation done.]